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TWO METHODS OF MEASURING THE SPECTRAL COEFFICIENTS OF LIGHT TRANSMISSION BY SUBSTANTIAL THICKNESSES OF SEA WATER

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16. Abstract

Two different methods of measurements of the light transmittance spectral coefficient T_λ for thick layers of the sea water by means of the meters with light spectral resolution are described. As an illustration some results of measurements of spectral distributions T_λ are given.

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TWO METHODS OF MEASURING THE SPECTRAL COEFFICIENTS OF LIGHT TRANSMISSION BY SUBSTANTIAL THICKNESSES OF SEA WATER

V.I. Eremin, G.G. Karlsen, V.N. Pelevin

It is well known that with an increase of the optical thickness of water, the spectral band of the transmission of light by it narrows. Results of the usual measurements of spectral transmission of light by sea water, that are conducted on samples of water or "in situ" in the case of small measurement bases, are hard to extend to layers of substantial thickness. This is connected, in particular, with the fact that at great distances, a significant role is played by diffused light, the effect of the influence of which is completely lost in the case of measurements on small bases. One can expect not only that the spectral path of the transmission curve will depend on the optical thickness of the layer, but also that the transmission maximum can shift. /120*

The index of the vertical attenuation of daylight is usually measured by receivers, covered colored light filters with a wide transmission band, commensurate with the band of the transmission of light by a large layer of water, which leads to significant errors. Therefore, for determining the transmission spectra, it is desirable to conduct measurements on significant thicknesses of water; one should select as a receiver an apparatus with high resolution along the spectrum.

A special apparatus was developed in two versions for work at night and in the day, with the use of monochromater UM-2.

In work at night, a transmitter was used, that is a xenon

*Numbers in right hand margin indicate pagination of foreign text.

impulse lamp of type IFK - 15000, positioned at the focus of a parabolic mirror. The power supply of the lamp was a powerful bank of capacitors of an overall capacity of 50 microfarads, charged up to a voltage potential of 6 kilivolts; in the case of operation in this regime of a long light impulse equal to 30 - 50 microseconds. The lamp with the power supply unit was immersed to a given level. The power assembly was placed in a container, /123 filled with oil and provided with a flexible diaphragm for equalizing the pressure inside and outside the container. On the upper cover of the container was fastened a reflector and lamp, surrounded by water. The electrical scheme of the transmitter is shown in Fig. 1. The power supply is delivered to the container from the edge of a ship along low-voltage cable KVD 4/1.5 from control assembly of an underwater transmitter (Fig. 2).

The receiver is a monochromator UM-2 with an attachment installed at its outlet slit, that contains a photomultiplier FEU-51, a single-stage amplifier, and a cathode follower on lamps 6S6B and 6S31B (Fig. 3). The received amplified signal enters the entrance of an oscillograph that operates in a liquid regime; the ray scan is triggered by a synchroimpulse at the moment of radiation of the light signal.

An example of the transmission spectrum of light in waters of the Mediterranean Sea measured by the given apparatus is shown in Fig. 4. The curves presented in the drawing were obtained by means of division of curves of the spectral distribution of amplitudes of signals, taken from depth z_1 by amplitudes of signals, taken from depth z_2. The affixes on the values of the spectral transmission coefficient T in Fig. 4 indicates the values of depth z_1 and z_2 in meters: $z_1 > z_2$.

The apparatus made it possible to immerse the source of /124

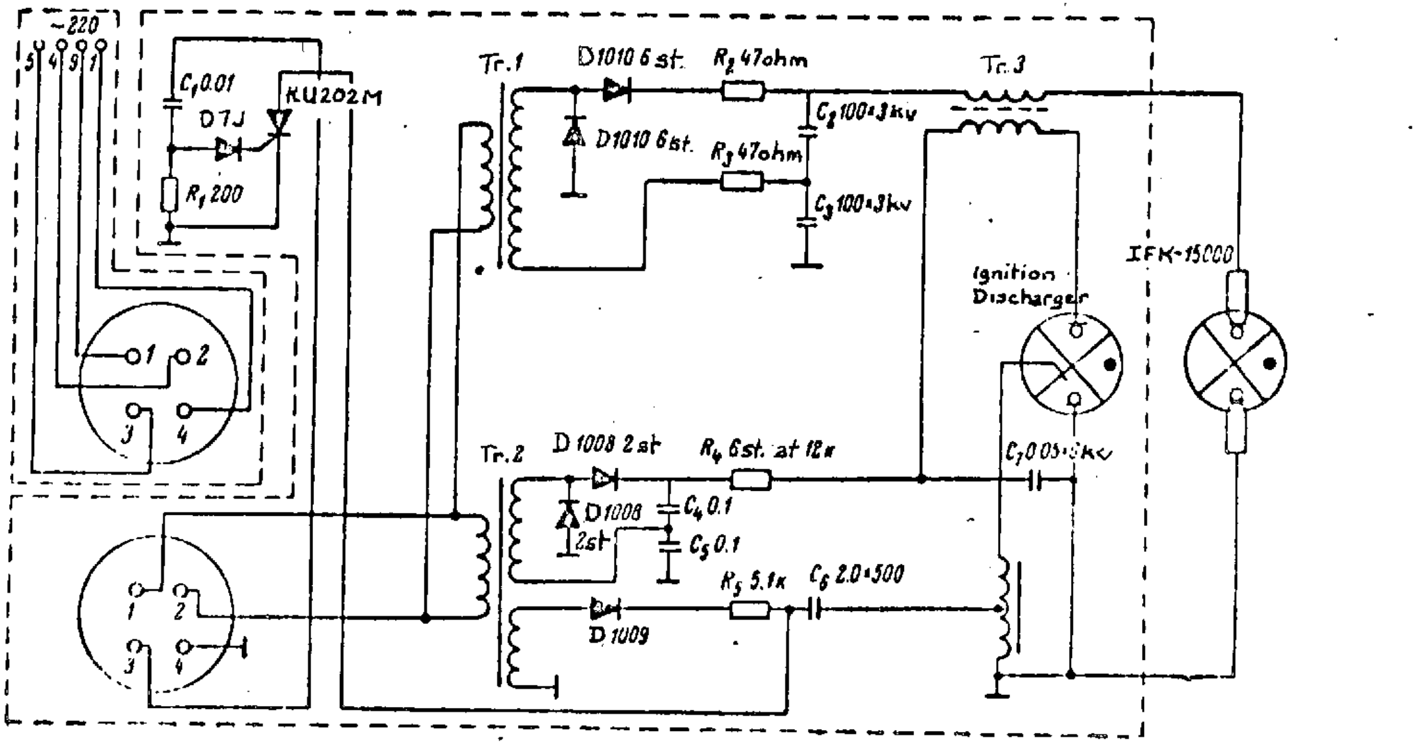

Figure 1. Electrical scheme of the radiator.

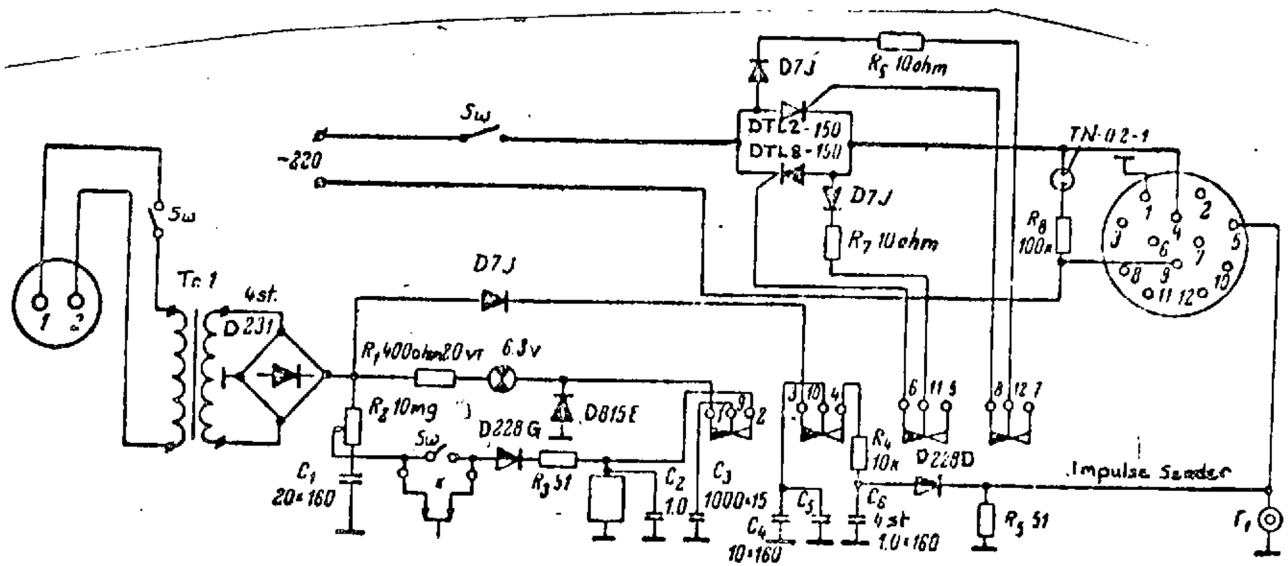

Figure 2. Control assembly of an underwater transmitter.

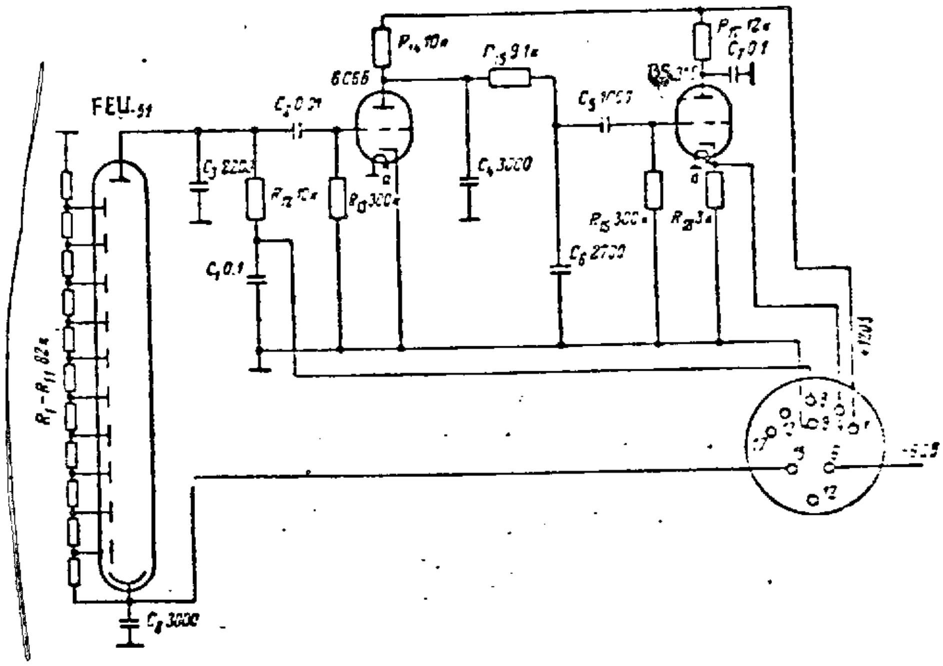

Figure 3. Photo-receiver to monochromator UM-2.

radiation to very substantial depths (down to 420 meters) and to maintain reception of a signal in the transmission band of 40 Angstroms.

The presented selective results make it possible to judge the width of the transmission band of the corresponding layers of water (in the conditions of the experiment, 50-65 nm at a level 50%) and the position of the transmission maximum (near to 485 nm). The indicated results attest to the usefulness of the apparatus and the procedure for conducting systematic investigations.

The coefficients of light transmission by sea water were measured likewise by another method. Monochromator type UM-2 with a photoelectric receiver in the outlet slit was immersed under water; with the help of it, the spectral coefficients of transmission of daylight by the sea were measured.

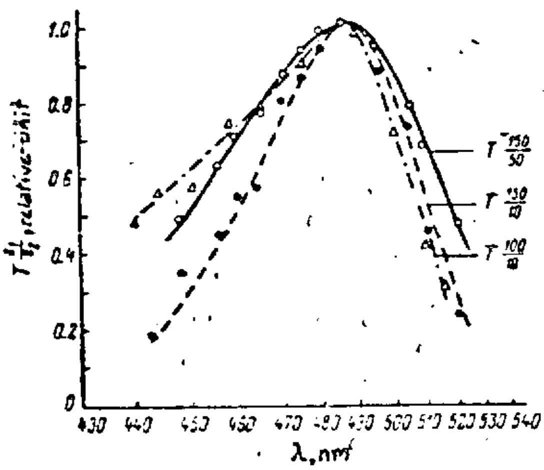

Fig. 4. An example of the spectra of transmission $T\frac{z_1}{z_2}$ of light by substantial thicknesses of sea water. $T\frac{100}{10}$ is water of the maximum transparency.

The spectral composition of sun light, measured by a monochromator immersed at depths 6 and 40 meters in one of the regions of the Black Sea, is presented in Fig. 5. There too is presented the quotient of division of the spectra by one another, which is the coefficient of transmission of solar radiation by a layer of water 34 meters in thickness.

Thus, in the first case the attenuation of a passing beam of light was measured, and in the second case the attenuation of an infinitely wide light flux was investigated. Naturally, it is impossible to demand that the spectral path of transmission coefficients prove to be equal. Nevertheless, inasmuch as by the first method we investigated a very large optical thickness, the basic part of the path, made in water by the light flux between the source and the receiver, pass through conditions of a deep or nearly deep regime, that is not sensitive to geometric characteristics of sources of light. On the basis of what has been said, we suppose that the results of measurements of coefficients /125

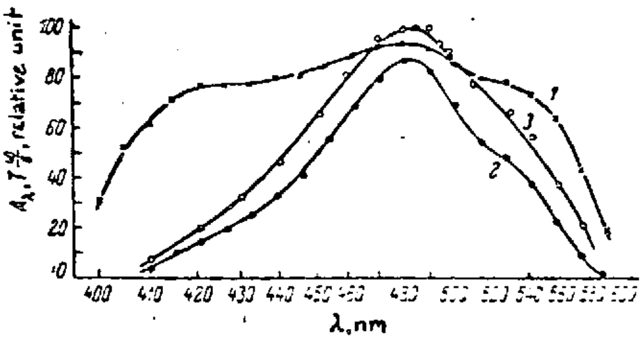

Figure 5. Spectral composition of solar radiation at depths 6 meters (1), 40 meters (2), and the transmission spectrum of solar light $T\frac{40}{6}$ (3) in waters of the Black Sea.

of light transmission by large thicknesses of water by both indicated methods should not substantially differ.

The method of measurements with an immersed impulse light source gives the greater variance of experimental points because of insufficient stability of the measuring channel and because of the effect of the waves on the surface of the water, but maintains with a simple measuring procedure the obtaining of transmission coefficients down to depths of several hundred meters.